DTIC FILE COPY

TION PAGE

Form Approved
OMB No. 0704-0188

AD-A221 945

1. TE

3. REPORT TYPE AND DATES COVERED
Final Report, 1 Nov 88 to 31 Oct 89

4. TITLE AND SUBTITLE
DEVELOPMENT OF PROBABILISTIC AND POSSEBILISTIC APPROACHES TO APPROXIMATE REASONING AND ITS APPLICATIONS

5. FUNDING NUMBERS
AFOSR-89-0084
61102F 2304/A7

(2)

6. AUTHOR(S)
Lotfi A. Zadeh

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
University of California
Computer Science Division
Berkeley, CA 94720

AFOSR-TR- 90-0394

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
AFOSR/NM
Building 410
Bolling AFB, DC 20332-6448

10. SPONSORING/MONITORING AGENCY REPORT NUMBER
AFOSR-89-0084

11. SUPPLEMENTARY NOTES

DTIC
ELECTE
MAY 04 1990
S D
D Cs

12a. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release;
distribution unlimited.

12b. DISTRIBUTION CODE

13. ABSTRACT (Maximum 200 words)

The research has been focused in the main on the development of fuzzy logic and its applications in three problem areas: (a) qualitative systems analysis; (b) imprecise knowledge representation; and (c) neural network control of fuzzy rule-based systems. These problem areas are of direct relevance to the analysis and design of both control and knowledge-based systems which operate in an environment of uncertainty or imprecision. In the realm of qualitative systems analysis, a basic problem which we have studied is the following. Assume that a system is comprised of an interconnection of n components, with the qualitative input-output relation of each component characterized by a collection of fuzzy if-then rules involving linguistic variables. The problem is to compute the qualitative input-output relation of the system from the specifications of the qualitative input-output relations of its components. An effective solution to this problem has been obtained through the use of what might be called FA-Prolog. FA-Prolog is a subset of Fuzzy Prolog in which the certainty factors are assumed to be equal to one. With this simplifying assumption, the fuzzy if-then rules can be handled in a straight-forward way and the determination of the qualitative input-output relation reduces to the execution of an FA-Prolog program.

14. SUBJECT TERMS

15. NUMBER OF PAGES
3

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIIFED	UNCLASSIFIED	UNCLASSIFIED	SAR

Final Report
AFOSR Grant No. AFOSR-89-0084

Development of Probabilistic and Possibilistic Approaches to Approximate Reasoning and Its Applications

Lotfi A. Zadeh

Computer Science Division
University of California, Berkeley, CA 94720

SUMMARY

Our research has been focused in the main on the development of fuzzy logic and its applications in three important problem areas: (a) qualitative systems analysis; (b) imprecise knowledge representation; and (c) neural network control of fuzzy rule-based systems. These problem areas are of direct relevance to the analysis and design of both control and knowledge-based systems which operate in an environment of uncertainty or imprecision.

In the realm of qualitative systems analysis, a basic problem which we have studied is the following. Assume that a system is comprised of an interconnection of n components, with the qualitative input-output relation of each component characterized by a collection of fuzzy if-then rules involving linguistic variables. (A simple example of such a rule might be: *if the pressure is high then the volume is low*.) The problem is to compute the qualitative input-output relation of the system from the specifications of the qualitative input-output relations of its components.

An effective solution to this problem may be obtained through the use of what might be called FA-Prolog. FA-Prolog is a subset of Fuzzy Prolog in which the certainty factors are assumed to be equal to one. With this simplifying assumption, the fuzzy if-then rules can be handled in a straight-forward way and the determination of the qualitative input-output relation reduces to the execution of an FA-Prolog program.

In the realm of imprecise knowledge representation, we have focused our attention on the representation of commonsense knowledge. The basic idea underlying our approach is that such knowledge may be assumed to consist of a collection of dispositions: that is, propositions which are preponderantly but not necessarily always true. Unlike the approaches which have become popular in AI (circumscription, non-monotonic reasoning, and default reasoning), our approach is based on fuzzy logic and, more specifically, on the theory of usuality.

In the realm of neural networks, a doctoral student, C.C. Lee, has opened a new direction with the development of a self-learning fuzzy control system which is tuned by a neural network. Simulation studies involving a pole-balancing system have shown that Lee's system learns significantly faster than the systems described in the literature and is substantially more robust.

It should be noted that fuzzy logic is finding its way into a wide variety of commercial products ranging from automobile transmissions and autofocus cameras to VLSI chip design and robot eyes. A representative sample of such applications is included in the Appendix.

Work credited to AFOSR 89-0084

Author	Title
Zadeh, L.A.	"Knowledge Reprsentation in Fuzzy Logic," *IEEE Transactions on Knowledge and Data Engineering 1*, 89-100, 1989.
Zadeh, L.A.	"QSA/FL—Qualitative systems analysis based on fuzzy logic," *Stanford AAAI Symposium on Limited Rationality*, Stanford, CA, 111-114, 1989.
Lee, C.C.	"Fuzzy logic in control systems: Fuzzy logic controller, Part I," *IEEE Trans. on Systems, Man, and Cybernetics 20*, 1990.
Lee, C.C.	"Fuzzy logic in control systems: Fuzzy logic controller, Part II," *IEEE Trans. on Systems, Man, and Cybernetics 20*, 1990.
Lee, C. C.	"A self-Learning Rule-Based Controller Employing Approximate Reasoning and Neural Concepts," to appear in the *International Journal of Intelligent Systems*, 1990.
Gil, Maria A.	"Sufficiency and Fuzziness in Random Experiments" U. Calif Memorandum No. UCB/ERL M89/101
Gil, Maria A. & P. Jain	"Comparison of Experiments in Decision Problems with Fuzzy Utilities" U. Calif. Memorandum No. UCB/ERL M89/103
Gil, Maria A. & P. Jain	"The Effects of Perfect and Sample Information on Fuzzy Utilities in Decision-Making" U. Calif. Memorandum No. UCB/ERL M89/104
Gil, P., M.A. Gil, M.L. Menendez, and L. Pardo	"Connections Between Some Criteria to Compare Fuzzy Information Systems" U. Calif. ERL Memorandum No. UCB/ERL M89/105